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THE WORK OF THE BELLE FOURCHE RECLAMATION PROJECT EXPERIMENT FARM IN 1918

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General View of the Farm Buildings on the Belle Fourche Reclamation Project Experiment Farm

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CONDITIONS ON THE PROJECT.

CLIMATIC CONDITIONS.

The precipitation for 1918 was 18.31 inches, which is 4.03 inches above the average for the last 11 years at the experiment farm. There was more snow than usual during the winter months, but the spring opened early and all fall-plowed land and land that had been in cultivated crops in 1917 was in excellent condition for planting. The rainfall in May and June was very light; consequently the crops on late spring plowing were very poor. During July, August, and September the precipitation was 9.48 inches, which is 3.42 inches more than the average for these months. The weather conditions for the fall months were excellent for harvest and fall plowing, and no severe freezing occurred until the first part of December. The project was free from serious animal or plant diseases, and there were no hailstorms except a small local storm on the northeast edge of the project. The last spring frost occurred on May 21 and the first fall frost on September 19, there being a frost-free period of 120 days, the 11-year average being 131 days.

Table I presents a summary of the climatological observations made at the Belle Fourche Experiment Farm from 1908 to 1918, inclusive.

CROP CONDITIONS.

Conditions during the early spring were very favorable to getting crops started. May and June were very dry, and irrigation had to be commenced earlier than in previous years. Irrigation water was available at all times. The area on the project from which crops were harvested in 1918 was 52,445 acres, included in 906 farms, an increase of 2,419 acres and 81 farms over 1917. The total irrigable area reported in 1918 was 70,651 acres, or 72.1 per cent of the project.

The total value of the crops produced was estimated at $1,276,115, an increase of $104,876 over that of 1917. The average value of all crops was estimated at $24.36 per acre in 1918.

The average yields and farm values of the crops produced on the Belle Fourche project in 1918 are shown in Table II, the figures being obtained from the United States Reclamation Service.

TABLE I.—*Summary of climatological observations at the Belle Fourche Experiment Farm, 1908 to 1918, inclusive.*

PRECIPITATION (INCHES).

Item.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Average for 11 years, 1908 to 1918	0.47	0.46	0.64	1.41	2.43	2.14	2.07	1.39	1.50	0.95	0.27	0.52	14.28
For 1918	.99	.64	.81	2.40	1.60	1.17	3.41	2.99	3.08	.22	.15	.85	18.31

EVAPORATION (INCHES).

Average for 11 years, 1908 to 1918	.....	.....	.....	4.14	5.44	6.94	8.24	6.95	4.85	.....	.....	.....	36.58
For 1918	.....	.....	.....	3.27	5.17	6.55	6.46	7.12	3.95	.....	.....	.....	32.52

WIND VELOCITY (MILES PER HOUR).[1]

Highest:													
1908 to 1918	18.8	16.7	19.6	26.8	25.3	20.7	19.4	17.6	26.3	18.3	21.7	28.0	.....
For 1918	.....	.....	.....	24.9	12.3	9.3	10.1	5.7	5.2	.....	.....	.....	.....
Lowest:													
1908 to 1918	.8	.8	1.7	1.3	1.1	1.7	1.5	1.0	.9	2.1	.9	1.8	.....
For 1918	.....	.....	.....	2.0	3.1	1.9	1.5	1.0	1.2	.....	.....	.....	.....
Mean:													
1908 to 1918	7.2	4.3	7.5	8.4	8.3	7.0	5.7	5.3	5.8	6.7	7.3	8.4	.....
For 1918	.....	.....	.....	9.2	6.6	4.5	4.2	2.8	2.2	.....	.....	.....	.....

MONTHLY TEMPERATURE (°F.).

Absolute maximum:													
1908 to 1918	61	62	87	89	95	108	109	105	105	91	78	66	.....
For 1918	58	55	75	76	90	100	100	100	90	84	78	66	.....
Absolute minimum:													
1908 to 1918	−37	−36	−20	5	22	33	40	32	22	− 1	−18	−31	.....
For 1918	−33	−24	− 2	18	31	33	49	42	26	17	−16	−16	.....
Mean:													
For 1908 to 1918	14	18	31	45	53	65	72	69	59	46	33	19	.....
For 1918	9	20	40	41	55	69	69	70	56	50	31	25	.....

KILLING FROSTS.

Year.	Last in spring.	First in fall.	Frost-free period (days).	Year.	Last in spring.	First in fall.	Frost-free period. (days).
1908	May 21	Sept. 22	128	1915	May 21	Sept 14	116
1909	May 18	Sept. 24	128	1916	May 16	...do....	121
1910	May 21	Sept. 26	127	1917	May 31	Oct. 8	130
1911	May 12	Oct. 4	146	1918	May 21	Sept. 19	120
1912	May 4	Sept. 25	144				
1913	May 6	Sept. 24	141	11-year average	.....	.....	131
1914	May 12	Oct. 4	145				

[1] Data incomplete for months of January, February, March, October, November, and December.

TABLE II.—*Acreage, yields, and farm values of the crops produced on the Belle Fourche Reclamation Project in 1918.*

Crop.	Area (acres).	Unit of yield.	Yield.			Farm value.		
			Total.	Per acre.		Per unit of yield.	Total.	Per acre.
				Average.	Maximum.			
Alfalfa hay	20,467	Ton	42,032	2.06	6.8	$12.00	$504,384	$24.72
Alfalfa seed	342	Bushel	362	1.06	5.0	9.00	3,258	9.54
Barley	1,636	do	40,775	24.90	87.5	1.00	40,775	24.90
Beans	146	do	1,561	10.69	40.0	4.20	6,556	44.90
Beets, sugar	1,087	Ton	10,603	9.77	17.0	9.00	95,427	87.93
Corn	2,068	Bushel	43,830	21.2	54.0	1.40	61,362	29.68
Corn fodder	848	Ton	1,848	2.12	3.5	8.00	15,072	16.96
Garden	421						17,618	41.90
Hay, native	3,209	Ton	3,610	1.12	3.8	18.00	64,980	20.16
Oats	4,331	Bushel	137,066	31.7	90.0	.70	95,946	22.19
Pasture	8,894						51,879	5.84
Potatoes	227	Bushel	23,380	103.0	400.0	.90	21,042	92.72
Rye	108	do	1,504	13.92	32.5	1.25	1,880	17.40
Wheat	9,563	do	152,674	15.7	55.0	1.90	290,080	29.83
Miscellaneous	312						5,856	18.75
Less duplicated areas	1,214							
Total	52,445						1,276,115	
Average								24.36

TABLE III.—*Acreage, production, and farm values of the principal crops grown on the Belle Fourche Reclamation Project, 1913 to 1918, inclusive.*

Item and year.	All crops.	Alfalfa hay.	Alfalfa seed.	Barley.	Corn.	Hay, native.	Oats.	Pasture.	Wheat.
Acreage:									
1913	32,568	7,388	1,576	744	1,859	2,533	5,343	285	13,096
1914	36,709	9,745	1,416	1,448	4,415	2,236	6,392	3,604	7,885
1915	42,866	16,152	284	1,613	4,470	2,782	4,440	3,273	7,747
1916	46,909	17,945	4,177	2,740	3,846	2,121	4,119	6,132	7,554
1917	50,026	19,702	942	2,286	2,902	4,475	4,955	6,100	5,122
1918	52,445	20,467	342	1,636	2,063	3,109	4,331	8,894	9,563
Production:		*Tons.*	*Bushels.*	*Bushels.*	*Bushels.*	*Tons.*	*Bushels.*		*Bushels.*
1913		15,854	2,157	18,801	35,615	2,232	161,765		195,205
1914		20,473	3,205	34,718	106,280	1,911	209,813		108,880
1915		34,842	65	47,365	64,098	2,507	165,260		133,248
1916		36,765	5,320	42,804	75,588	1,749	91,767		38,222
1917		35,692	2,335	55,164	46,290	3,108	106,309		67,095
1918		42,032	362	40,775	43,830	3,610	137,066		152,674
Average yield per acre:									
1913		2.1	1.4	24.3	19.1	0.9	30.3		14.9
1914		2.1	2.3	24.0	24.1	.9	32.8		13.8
1915		2.2	.2	29.3	14.3	.9	37.3		17.2
1916		2.0	1.3	15.6	19.6	.8	22.1		5.1
1917		1.8	2.5	24.2	15.9	.7	21.5		13.1
1918		2.0	1.0	24.9	21.2	1.1	31.7		15.7
Farm value per unit of yield:									
1913		$4.50	$6.00	$0.60	$0.80	$10.00	$0.40		$0.60
1914		4.50	7.30	.70	.70	10.00	.40		.90
1915		4.50	10.00	.65	.50	10.00	.40		.80
1916		7.00	8.00	.70	.80	9.50	.40		1.25
1917		15.00	8.00	1.25	2.00	16.00	.70		1.90
1918		12.00	9.00	1.00	1.00	18.00	.70		1.90
Farm value per acre:									
1913	$10.91	9.65	8.21	14.59	15.32	8.81	12.11	$6.98	8.94
1914	12.56	9.46	16.51	16.77	16.85	8.55	13.12	3.25	12.41
1915	10.80	9.90	2.00	19.05	7.15	9.00	14.92	4.32	13.76
1916	11.88	14.34	10.19	10.94	15.72	7.83	8.91	4.55	6.32
1917	23.50	27.20	19.80	30.00	31.90	11.10	15.00	7.28	24.80
1918	24.36	24.72	9.54	24.90	29.68	20.16	22.19	5.84	29.83
Total farm values:									
1913	355,380	71,343	12,492	10,861	28,492	22,320	64,706	1,990	117,123
1914	461,188	92,129	23,397	24,303	74,396	19,110	83,925	12,078	97,992
1915	462,050	156,789	650	30,787	32,049	25,070	66,104	14,105	106,598
1916	557,342	257,355	42,560	29,963	60,470	17,615	36,707	27,826	47,778
1917	1,171,239	535,380	18,680	68,955	92,580	49,728	74,416	66,709	127,489
1918	1,276,115	504,384	3,258	40,775	61,362	64,980	95,946	51,879	290,080

Table III shows the annual average production and farm values of the principal crops grown on the Belle Fourche project in the years 1913 to 1918, inclusive, based on data obtained from the United States Reclamation Service. Alfalfa is the principal crop on the Belle Fourche project and has shown a steady increase in acreage, until in 1918 the total acreage planted to alfalfa was 20,467 acres, or 39 per cent of the actual irrigable land. Barley, corn, and oats show slight decreases, while the acreage in wheat in 1918 was very nearly double the 1917 crop. The average yield per acre has remained rather low every year, this being due chiefly to the fact that large areas of new land have been broken up and planted. Much of this land is poorly farmed, and the yields secured are low, so the average for the project is very much reduced. The farm values per acre and the total farm values of all crops in 1917 and 1918 were practically doubled, as compared with the average for 1916 and the preceding three years, but this was due to increased market values rather than to increased production.

LIVE STOCK.

Table IV shows the live stock on hand on January 1 and December 31, 1918, their value, and the increase in total value. These figures were obtained from the United States Reclamation Service.

TABLE IV.—*Inventory of live stock on the Belle Fourche Reclamation Project in 1918.*

Item.	Inventory, Jan. 1.			Inventory, Dec. 31.			Increased total value.[1]
	Number.	Value.	Total value.	Number.	Average value.	Total value.	
Horses	3,734	$91.16	$340,482	3,877	$75.47	$300,590	—$39,892
Mules	88	108.24	9,505	97	83.76	8,125	— 1,380
Cattle:							
Beef	6,616	50.53	334,295	4,801	63.18	303,315	— 30,980
Dairy	2,912	60.65	176,618	3,330	66.69	222,060	45,442
Sheep	36,459	12.69	461,346	35,607	11.00	391,595	— 69,751
Hogs	10,946	15.10	165,240	9,007	15.12	136,141	— 29,099
Fowls	24,028	.73	17,612	18,975	.63	11,948	— 5,664
Bees, hives	541	5.34	2,888	852	7.33	6,242	3,354
Total			1,507,986			1,380,016	—127,970

[1] The minus sign indicates decrease in value.

The total number of live stock on hand at the close of each year and their value, as ascertained by the United States Reclamation Service, for the years 1913 to 1918, inclusive, are shown in Table V. The principal live-stock industries show a slight decrease in 1918, except dairy cattle. This decrease in live stock was probably caused by the ready sale of all feeds and also the high price received for stock. The total value of all stock on the project at the close of 1918 was estimated at $1,380,016.

TABLE V.—*Inventory and value of live stock on hand on the Belle Fourche Reclamation Project at the close of each year for the 6-year period, 1913 to 1918, inclusive.*

Live stock.	1913	1914	1915	1916	1917	1918
Number:						
Horses	2,490	2,848	3,135	3,514	3,734	3,877
Mules	89	59	65	86	88	97
Cattle:						
Beef	[a] 2,758	2,514	5,524	8,178	6,616	4,801
Dairy		1,578	2,200	2,870	2,912	3,330
Sheep	12,872	25,740	26,210	32,152	36,459	35,607
Hogs	4,636	11,988	14,798	13,631	10,946	9,007
Fowls	23,125	29,186	21,315	27,094	24,028	18,975
Bees, hives	139	129	326	541	541	852
Average value per head:						
Horses	$90.32	$87.50	$92.80	$88 83	$91.18	$75.47
Mules	83.65	112.10	120.00	104.30	108.24	83.76
Cattle:						
Beef	[a] 46.14	46.50	47.60	42.58	50.53	63.18
Dairy		57.75	56.10	56.92	60.65	66.69
Sheep	3.76	3.76	4.48	5.65	12.65	11.00
Hogs	8.75	8.97	6.75	8.48	15.10	15.12
Fowls	.46	.49	.48	.47	.73	.63
Bees, hives	5.76	6.20	7.45	5.34	5.34	7.33
Total value:						
Horses	224,891	249,150	290,875	312,160	340,482	300,590
Mules	7,445	6,635	7,805	8,970	9,505	8,125
Cattle:						
Beef	[a]127,214	116,901	262,480	348,214	334,295	303,315
Dairy		91,129	123,195	163,355	176,618	222,060
Sheep	48,471	96,782	117,296	181,659	461,346	391,595
Hogs	40,576	107,772	99,640	115,613	165,240	136,141
Fowls	10,586	14,252	12,533	12,648	17,612	11,948
Bees, hives	801	801	2,429	2,888	2,888	6,242
Total	459,984	683,422	916,253	1,145,507	1,507,986	1,380,016

[a] Beef and dairy cattle for 1913 were not segregated.

Table VI shows the number of carloads of cattle, sheep, hogs, and horses shipped from and received at the four project towns during the years 1916, 1917, and 1918, according to figures obtained from the district freight office at Deadwood, S. Dak.

TABLE VI.—*Carload lots of live stock shipped from and received at four shipping points on the Belle Fourche Reclamation Project in 1916, 1917, and 1918.*

Shipping point.	Cattle.			Sheep.			Hogs.			Horses.		
	1916	1917	1918	1916	1917	1918	1916	1917	1918	1916	1917	1918
Forwarded:												
Belle Fourche	406	760	641	231	216	174	50	35	15	84	98	94
Fruitdale	28	72	27	10	35	24	19	13	3	2	7	.....
Nisland	28	92	51	12	39	19	43	29	17	2	1	24
Newell	162	233	202	118	131	56	81	77	48	11	5	11
Total	624	1,157	921	377	421	273	193	154	83	99	111	129
Increase or decrease (—) as compared to 1917	.....	.....	—236	.....	.....	—148	.....	.....	—71	.....	.....	18
Received:												
Belle Fourche	180	36	150	31	14	30	1	6	1	10	19	2
Fruitdale	20	.....	1	1	3	.....	1	1	4	.....	1	.....
Nisland	14	7	8	14	5	8	.....	1	.....	.....	.....	.....
Newell	85	57	8	72	53	24	.....	.....	1	3	.....	3
Total	299	100	167	118	75	62	2	8	6	13	20	5
Increase or decrease (—) as compared to 1917	.....	.....	67	.....	.....	—13	.....	.....	—2	.....	.....	—17

The total number of carloads shipped from the four project towns in 1918 was 1,406, a decrease of 437 carloads over 1917. During the same period 240 cars were received, showing an increase of 37 carloads as compared with 1917.

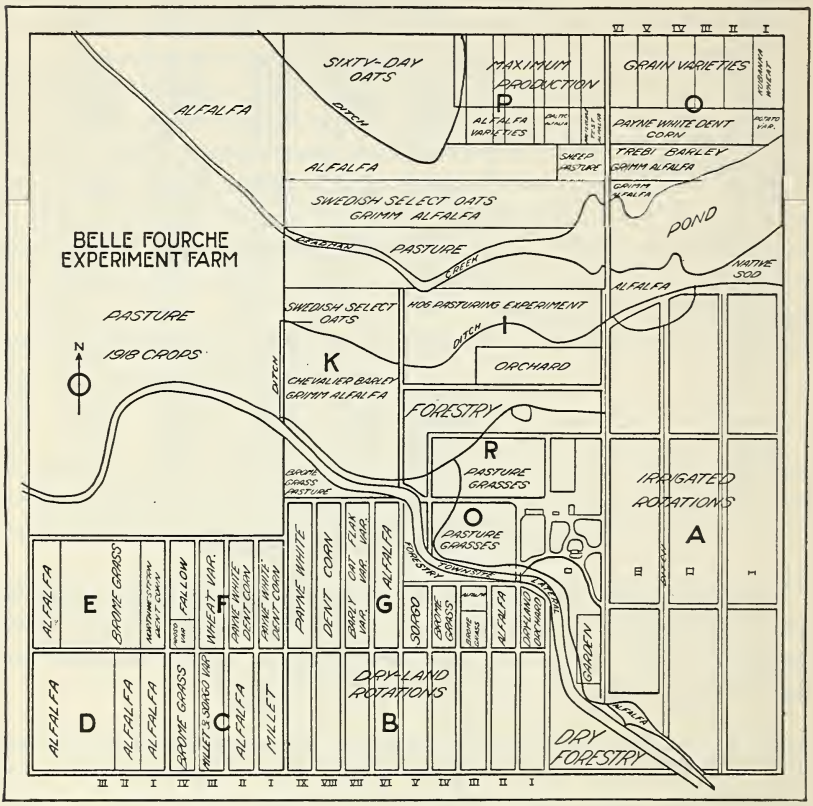

FIG. 1.—Diagram of the Belle Fourche Experiment Farm, showing the arrangement of the fields and the location of the crop experiments in 1918.

SCOPE OF THE INVESTIGATIONS.[1]

The work of the farm is devoted mainly to experiments in the production and utilization of crops under irrigation on the Belle Fourche Reclamation Project and adjacent areas. It relates chiefly to crops of local importance and includes experiments in crop rotation and tillage, tests of grain and forage crops, experiments in hog and sheep

[1] The Belle Fourche Experiment Farm includes 300 acres of land on the Belle Fourche Reclamation Project near Newell, S. Dak. Earlier reports have been published as follows: Bureau of Plant Industry Circular No. 119, issued Mar. 29, 1913; unnumbered circular of the Office of Western Irrigation Agriculture, issued Sept. 8, 1914, "The Work of the Belle Fourche Reclamation Project Experiment Farm in 1913;" W. I. A. Circular No. 4, issued Aug. 28, 1915, "The Work of the Belle Fourche Reclamation Project Experiment Farm in 1914;" W. I. A. Circular No. 9, issued Oct. 12, 1916, "The Work of the Belle Fourche Reclamation Project Experiment Farm in 1915;" W. I. A. Circular No. 14, issued Sept. 22, 1917, "The Work of the Belle Fourche Reclamation Project Experiment Farm in 1916;" and W. I. A. Circular No. 24, issued November, 1918, "The Work of the Belle Fourche Reclamation Project Experiment Farm in 1917."

production, tests of pasture grasses, of trees for windbreak and ornamental plantings, of garden vegetables, and of orchard and small fruit. Figure 1 shows the arrangement of the fields and the location of the experiments in 1918.

The farm is in charge of the Office of Western Irrigation Agriculture of the Bureau of Plant Industry, and facilities are provided for special investigations carried on by other agencies of the Department of Agriculture. The Bureau of Animal Industry in 1917 inaugurated experiments relating to hog production. This includes the testing of various feeds and quantities of grains used as supplements to alfalfa pasture, the cost of carrying breeding sows through the season, and the harvesting of corn with hogs in the field. The Office of Dry-Land Agriculture uses about 20 acres of land above the canal for rotation and tillage experiments. The Office of Cereal Investigations has charge of the variety testing and breeding of small grain. The Office of Alkali and Drought Resistant Plant Investigations does the variety testing and breeding of forage crops and conducts studies of the water requirements of the different varieties and strains tested. These four offices have assistants detailed to the farm to supervise the work. The Biophysical Laboratory cooperates in all climatological and physical observations. This work includes measurements of rainfall, wind velocity, evaporation, temperature, and soil moisture. The testing of trees for wood-lot and windbreak purposes is carried on in cooperation with the Forest Service.

Certain of these cooperative investigations are summarized in the following pages, and progress is reported on the experiments with the production and utilization of irrigated crops.

ROTATION EXPERIMENTS WITH IRRIGATED FIELD CROPS.

DESCRIPTION OF THE ROTATIONS.[1]

The rotation experiments now occupy 129 plats of one-fourth acre each in field A (see fig. 1). They were first begun in 1912. With the season of 1918 these experiments complete the seventh year. It now becomes possible to see in the results obtained some facts which may be useful to those engaged in crop production under similar conditions.

CROP YIELDS.

Table VII shows the maximum, minimum, and average yields per acre in the irrigated rotation experiments on the Belle Fourche Experiment Farm in 1918 and a comparison of the average yields in six previous years, indicating a wide difference between the highest and the lowest yields obtained from the different plats. In most cases the maximum yield was more than twice the minimum. With the

[1] For a detailed list of these experiments, see "The Work of the Belle Fourche Reclamation Project Experiment Farm in 1917," W. I. A. Circular No. 24, issued November, 1918.

exception of alfalfa each crop was planted at the same time on the various plats. The same variety of seed was used on all plats and the cultural treatment was the same, so the difference in yield must be due to the differences in the plats. These differences between the plats may be due in part to soil variation and in part to the effect of the preceding crop or to the application of manure.[2] During the first year of a rotation experiment the soil variation is an important factor, but this may be materially reduced as time goes on. The average yield of alfalfa shown in Table VII includes the records of all plats in the rotations. The maximum yield of alfalfa two or more years old was 4.88, the minimum 3.14, and the average 3.97 tons per acre.

TABLE VII.—*Yields of crops grown in the irrigated rotation experiments on the Belle Fourche Experiment Farm, 1912 to 1918, inclusive.*

Number of plats, 1918.	Crop.	Yield per acre, 1918.			Comparison of average yield per acre.					
		Maximum.	Minimum.	Average.	1912	1913	1914	1915	1916	1917
31	Alfalfa hay.....tons..	4.88	1.48	3.27	.....	2.6	3.0	3.17	3.42	3.0
22	Sugar beets.....do....	14.78	5.84	10.24	7.6	7.8	11.6	9.2	7.6	12.35
7	Corn.....bushels..	80.0	28.5	40.0	28.7	34.0	43.6	27.6	39.5	42.92
3	Winter wheat.....do....	26.5	14.9	21.7	.....	11.3	22.9	27.1	11.9	19.9
7	Spring wheat.....do....	44.1	12.1	25.0	22.1	19.9	25.7	20.9	10.0	27.8
26	Oats.....do....	92.6	34.4	73.0	51.9	39.0	78.8	92.1	54.7	59.2
2	Barley.....do....	26.8	16.8	21.8	28.0	14.8	31.7	51.2	24.4	27.0
4	Flax.....do....	24.1	8.7	17.7	13.6	13.4	14.8	15.1	7.07	14.6
18	Potatoes.....do....	236	24.3	164.3	45.5	112.5	105.9	116.8	153.8	148.7
1	Clover hay.....tons..	.....	.....	1.28	.....	.....	.44	1.18	.66	.....
1	Clover seed.....bushels..	.....	.....	1.0	.....	.....	.....	1.77	2.08	.....

The yield of oats, potatoes, and beets in 1918 and the preceding crop in each case are shown in Table VIII. The yields of each crop are arranged in order from the highest to the lowest, showing which preceding crop gave the best results in 1918. It should be borne in mind that not all plats are equally good soil and that differences in yield are due to soil variation as well as to crop sequence.

The maximum yield of oats was 92.6, the minimum 34.4, and the average 73 bushels per acre. The maximum yield was obtained in a 6-year rotation of corn (sheeped), beets (tops sheeped), and oats, followed by three years of alfalfa, the third-year alfalfa being pastured with sheep. The minimum yield was obtained from a continuously cropped oat plat. Satisfactory results have always been obtained with oats after potatoes or beets, while after corn it has not been so good except where the corn has been pastured. So far, rotations with manure have not shown a decided increase in the yield of oats.

The maximum yield of potatoes was 236, the minimum 24.3, and the average 164.3 bushels per acre. The highest yield was obtained in a 2-year rotation of oats (manured) and potatoes and the lowest

[2] See also Scofield, C. S., Effect of farm manure in stimulating the yields of irrigated field crops. In Jour. of Agr. Research, v. 15, no. 9, pp. 493–503, 1918.

in a 2-year rotation of oats (rye plowed under) and potatoes. The extremely low yield in this rotation was caused by a poor stand, the plat being spring plowed. The best yields were obtained in 2-year and 3-year rotations with manure. The yields after alfalfa were more satisfactory than in previous years. Those in 1918 were the best obtained since the experiment was begun, but even these yields are low as compared with those obtained on lighter soil.

TABLE VIII.—*Yields per acre of oats, potatoes, and beets, showing the preceding crop in the irrigated rotations on the Belle Fourche Experiment Farm in 1918.*

[The application of manure wherever noted was made after the preceding crop mentioned was harvested.]

Rank.	Oats.			Potatoes.			Beets.		
	Preceding crop.	Rotation No.	Yield.	Preceding crop.	Rotation No.	Yield.	Preceding crop.	Rotation No.	Yield.
			Bush.			*Bush.*			*Tons.*
1	Beets (tops sheeped).	71	92.6	Oats (manured)	25	236.0	Potatoes	34	14.78
2	Potatoes	27	92.1	do	31	231.3	Potatoes (manured).	35	14.50
3	Beets	23	91.9	Beets (manured)	21	215.7	Corn (sheeped)	71	14.32
4	Potatoes	25	90.6	Alfalfa	40	203.3	Oats (manured)	61	13.76
5	Corn (hogged)	69	89.8	Oats	24	191.3	Oats	60	13.74
6	Potatoes	24	89.6	Corn	26	187.9	Potatoes	21	13.24
7	Beets	22	86.8	Oats	34	179.1	do	64	12.32
8	Wheat	48	86.3	Alfalfa	60	170.0	Oats (manured)	31	12.22
9	Potatoes	44	83.4	Beets	30	168.2	do	23	11.58
10	Flax	65	82.9	Potatoes	4a	168.0	Potatoes	40	11.01
11	Beets	35	82.9	Beets	20	166.7	do	20	10.88
12	Potatoes	61	81.1	Alfalfa	61	164.7	Oats	62	9.94
13	do	31	80.8	Oats (manured)	35	162.7	do	42	8.92
14	do	60	77.8	Alfalfa	44	152.7	do	22	8.56
15	Beets	34	73.9	do	64	144.7	Wheat	18	8.00
16	do	64	71.2	Beets	30a	133.3	Oats	30a	7.76
17	Potatoes	30	70.4	Potatoes	4	59.0	do	30	7.34
18	Corn	62	66.8	Oats (rye plowed under).	27	24.3	Clover	66	7.20
19	Potatoes	30a	66.0				Beets	2a	6.70
20	Corn	16	57.8				Alfalfa	46	6.64
21	Beets	464	56.0				Oats	32	6.02
22	Oats	1a	55.6				Beets	2	5.84
23	Corn	32	53.6						
24	Alfalfa	42	48.3						
25	Wheat	28	36.3						
26	Oats	1	34.4						
	Average, all plats		73.0			164.3			10.24

The maximum yield of sugar beets was 14.78, the minimum 5.84, and the average 10.24 tons per acre. The maximum yield was obtained in a 3-year rotation, beets following potatoes, and the minimum in a plat continuously cropped to beets for seven years. The analysis of 22 samples showed that the maximum percentage of sugar was 22.4, the minimum 10.9, and the average 19.9. The maximum percentage of purity was 93.9, the minimum 85.1, and the average 88.8. The average sugar content of the beets grown in the rotation experiments for the seven years from 1912 to 1918, inclusive, was 14.8, 19.1, 22.1, 17.7, 19.1, 20.2, and 19.9 per cent, respectively.

The maximum yield of wheat was 44.1, the minimum 12.1, and the average 25 bushels per acre. The maximum yield was obtained in

rotation 48, wheat following alfalfa, and the minimum in a plat continuously cropped for seven years.

The best yield of flax was 24.1, the minimum 8.7, and the average 17.6 bushels per acre. The maximum yield was obtained in a 6-year rotation, flax following beets, and the minimum on flax continuously cropped for seven years. This was the first year that the continuously cropped flax began to show any serious signs of wilt. Flax has given uniformly good results following a cultivated crop. The 7-year average for rotations 65 and 66 is 17.2 and 16.7 bushels per acre, respectively.

The corn yields in 1918 were very satisfactory. The highest yields of corn have been obtained after alfalfa pastured with hogs or sheep and are reported under hogging corn. The maximum yield of corn of the plats harvested was 48 bushels per acre, the minimum 28.5 bushels, and the average 40 bushels.

The observations made on crops in the irrigated rotation experiments in 1918 were similar to those of the previous year, the most important of which are as follows: Alfalfa has shown no marked increase in yield on crops that follow except where pastured by hogs or sheep. Grains following a cultivated crop have given better net returns per acre than when following alfalfa or grain. The application of manure has shown a marked increase in the yields of potatoes and sugar beets but not of grains. Sugar beets following potatoes or corn have given uniformly good results, and sugar beets following a grain crop without manure and after clover have given uniformly poor results. Alfalfa seeded after the grain has been harvested in late summer has given the most satisfactory stands and produced higher yields the first year after planting. Early-seeded spring grains have given much better results as to both quality and yield than late-seeded spring grains. Fall plowing should be practiced to a much larger extent than is common on the project. Some of the low yields obtained by farmers on the project are due to spring plowing more than to any other one factor.

SMALL-GRAIN VARIETAL EXPERIMENTS.[1]

WINTER WHEAT AND RYE.

Winter wheat and rye were sown on triplicated fiftieth-acre plats on corn ground, which was irrigated, double disked, and harrowed previous to seeding. In spite of the fact that the soil contained plenty of moisture, poor stands were obtained in the fall. Part of the seed germinated in the spring, and fair stands were secured on all varieties. The wheat was seeded at the rate of 4 pecks and the rye at 5 pecks per acre. All winter grains were irrigated twice. Turkey (selection C. I. No. 3055–159) has produced the highest yield of grain

[1] Conducted in cooperation with the Office of Cereal Investigations, Bureau of Plant Industry.

during each of the 4 years, with Kharkof (C. I. No. 1583) second. Winter wheat has outyielded winter rye every year during the experiment. Emmer and spelt are not sufficiently hardy for this region and were not grown in 1918. The yields are shown in Table IX.

TABLE IX.—*Annual and average yields of varieties of winter wheat, rye, emmer, and spelt grown on the Belle Fourche Experiment Farm in the 4-year period from 1915 to 1918, inclusive.*

Group, and variety.	C. I. No.[a]	Yield per acre (bushels).				
		1915	1916	1917	1918	4-year average.
WHEAT.						
Crimean:						
Kharkof	1583	66.3	11.3	29.5	23.4	32.6
Do	4207	61.3	.....	.....	.....	.....
Turkey	3055	.....	8.7	26.7	24.3	.....
Turkey selection	3055–159	66.6	11.5	31.0	26.5	33.9
Beloglina	1667	[b] 52.1	8.7	30.7	21.0	28.9
Ghirka winter:						
Ghirka	1438	.....	8.8	19.9	.....	.....
Ghirka winter selection	5298	57.5	.....	.....	.....	.....
Do	1437–394	51.9	.....	.....	.....	.....
Do	5297	59.1	5.2	28.5	26.5	29.8
RYE.						
Swedish (Minnesota No. 2)	137	44.6	10.8	21.3	17.5	23.5
North Dakota No. 959	175	[b] 38.8	11.7	25.4	14.8	22.6
EMMER.						
Buffum Black Winter	3331	.....	[b] 13.2	.....	.....	.....
SPELT.						
Beardless Brown Winter	.....	.....	[b] 7.8	.....	.....	.....

[a] Cereal investigations number. [b] One plat only.

TABLE X.—*Annual and average yields of varieties of spring wheat grown on the Belle Fourche Experiment Farm in the 7-year period from 1912 to 1918, inclusive.*

Group and variety.	C. I. No.	Yield per acre (bushels).							Average.	
		1912	1913	1914	1915	1916	1917	1918	1912 to 1918	1913 to 1918
DURUM.										
Kubanka	1440	20.8	18.6	22.8	22.0	20.6	25.2	41.7	24.5	25.1
Acme	5284	.....	.....	.....	.....	.....	.....	39.2	.....	.....
COMMON.										
Fife:										
Power	3025	19.5	17.0	17.0	14.7	8.4	27.3	35.0	19.8	19.9
Saskatchewan	.....	.....	.....	14.9	12.1	.....	.....	.....	.....	.....
Marquis	3276	.....	18.3	18.3	18.0	9.4	20.1	35.0	.....	19.8
Ghirka Spring	1517	16.4	.....	.....	.....	.....	.....	.....	.....	.....
Bluestem: Haynes	2874	22.0	14.2	15.4	11.5	7.3	19.8	30.7	17.2	16.4
Preston: Pringle Champlain	4782	.....	.....	19.0	12.2	6.5	29.5	37.6	.....	.....
Miscellaneous: Defiance	3703	.....	11.7	18.0	8.0	2.0	.....	.....	.....	.....

SPRING WHEAT.

The Kubanka variety of durum wheat (C. I. No. 1440) was seeded on disked corn ground in the same series with the varieties of winter wheat. Six varieties of common spring wheat were sown on disked

potato ground. This ground was manured at the rate of 12 loads per acre in the fall of 1916. The wheat was seeded at the rate of 5 pecks per acre in triplicated fiftieth-acre plats. The wheat was irrigated twice. The Kubanka variety has given the highest average yield during the period of the experiment, as well as the highest yield this past season. Of the common wheats the Pringle Champlain and the Marquis appear to be the best. The yields of the spring wheat varieties are shown in Table X.

OATS.

The oat varieties in 1918 were seeded on disked corn ground. This land was manured in the fall of 1916 at the rate of 12 loads per acre and was fall plowed for the corn crop in 1917. The oats were seeded at the rate of 10 pecks per acre in triplicated fiftieth-acre plats. The yields this year were the highest so far obtained in the variety test. The oats were irrigated three times. A midseason variety, the Canadian (C. I. No. 444) gave the highest average yield. The Silvermine is one of the most promising of the midseason varieties of oats and has the highest 4-year average. The White Russian, a very late side oats, is second in the 4-year averages. The early varieties have not done as well under irrigation as the midseason and late varieties, though on the dry lands they often succeed better.

The yields of oat varieties under irrigation during the last seven years are shown in Table XI.

TABLE XI.—*Annual and average yields of oat varieties grown on the Belle Fourche Experiment Farm in the 7-year period from 1912 to 1918, inclusive.*

Group and variety.	C. I. No.	Yields per acre (bushels).								
		1912	1913	1914	1915	1916	1917	1918	Average. 1912 to 1918.	Average. 1915 to 1918.
Early:										
Sixty Day	165	[a] 25.0	47.1	32.5	34.0	28.8	51.5	75.0	42.0	47.3
Kherson	459	[a] 30.4	.....	.....	.....	.....	.....	.....	.....	.....
Albion (Iowa No. 103)	729	.....	.....	.....	.....	20.2	.....	.....	.....	.....
Richland (Iowa No. 105)	787	.....	.....	.....	.....	18.1	.....	.....	.....	.....
Midseason:										
Swedish Select	134	[a] 35.2	33.0	41.6	46.5	36.9	54.6	77.9	46.5	54.0
Canadian	444	31.2	39.3	42.4	44.7	25.9	65.8	85.2	47.8	55.4
Lincoln	781	.....	.....	.....	50.7	36.1	52.8	74.2	.....	53.4
Silvermine	782	.....	.....	.....	52.3	41.6	61.1	79.2	.....	58.5
Peter Edwards [b]	778	.....	.....	[a] 50.7	51.8	37.4	57.8	73.7	.....	55.2
Great Dane	.....	.....	.....	[a] 32.8	.....	.....	.....	.....	.....	.....
Abundance	780	.....	.....	.....	.....	35.3	57.0	72.7	.....	.....
Danish	.....	.....	.....	.....	.....	34.8	.....	.....	.....	.....
Late:										
Mammoth Cluster	770	.....	.....	[a] 43.7	.....	24.7	.....	.....	.....	.....
White Russian	551	[a] 41.4	33.7	48.6	52.8	42.1	56.2	75.3	50.0	56.6
White Tartarian	300	[a] 46.8	.....	.....	.....	.....	.....	.....	.....	.....

[a] One plat only.
[b] Obtained from a farmer named Edwards, living in the vicinity of the experiment farm; similar to Swedish Select.

BARLEY AND SPRING EMMER.

Six varieties of barley were seeded on disked potato ground. The land was manured at the rate of 12 loads per acre and fall plowed in 1916 for the potato crop in 1917. The barley was seeded at the rate of 6 pecks per acre in triplicated fiftieth-acre plats. In the same series three plats of white spring emmer were sown at the rate of 8 pecks per acre, for comparison with the barley. All plats were irrigated twice. The yields of emmer in pounds of grain per acre have been less than the better varieties of barley. The Chevalier (C. I. No. 530), a 2-rowed variety, has produced well during the last year and is recommended for growing under irrigation in this section. The Trebi (C. I. No. 936), a 6-rowed variety, produced the highest yield in 1918. This variety has been grown for only two years in the varietal test, but appears to be promising for this section.

The annual yields from 1912 to 1918, inclusive, with the average for the last five years, are shown in Table XII.

TABLE XII.—*Annual and average yields of barley and spring emmer on the Belle Fourche Experiment Farm in the 7-year period from 1912 to 1918, inclusive.*

Group and variety.	C. I. No.	Yield per acre (bushels).							
		1912	1913	1914	1915	1916	1917	1918	Average, 1914 to 1918.
Six-rowed hulled:									
Coast	690	.....	.....	.....	23.0	15.2	37.9	65.6	.....
Manchuria (Wis. No. 13)	905	.....	25.8	21.8	20.9	14.7	23.9	66.7	29.6
Manchuria (Minn. No. 6)	638	16.9	.....	.....	.....	.....	.....	.....	.....
Manchuria (Minn. No. 105)	354	.....	23.5	17.8	.....	.....	.....	.....	.....
Odessa	182	17.4	.....	.....	.....	.....	.....	.....	.....
Trebi	936	.....	.....	.....	.....	.....	38.0	75.9	.....
Two-rowed hulled:									
Chevalier	1142	.....	.....	26.8	37.2	23.2	.....	.....	.....
Chevalier II	530	13.0	.....	23.0	39.2	23.9	38.5	74.3	39.8
Hannchen	531	19.8	32.9	15.0	.....	25.1	40.7	66.9	.....
Six-rowed naked:									
Himalaya (Guy Mayle, awned)	620	.....	.....	26.6	23.4	17.5	23.7	62.7	30.8
Nepal (white hull-less, hooded)	595	9.1	.....	19.2	20.4	14.9	22.3	.....	.....
Emmer:									
White Spring[a]	1524	24.5	27.8	34.0	58.0	35.6	57.7	88.0	54.6

[a] Yields of emmer are computed at 32 pounds per bushel.

FLAX.

The flax varieties in 1918 were seeded on disked beet ground in triplicated fiftieth-acre plats at the rate of 30 pounds per acre. This ground was manured at the rate of 12 loads per acre in 1916 and was fall plowed for the crop of sugar beets in 1917. The flax was irrigated twice. The yields in 1918 were very satisfactory. The highest yielding variety was the Damont (C. I. No. 3). This variety and the Russian (C. I. No. 19) have proved to be most satisfactory for this district.

The annual and average yields for the seven years, 1912 to 1918, inclusive, are shown in Table XIII.

TABLE XIII.—*Annual and average yields of varieties of flax grown on the Belle Fourche Experiment Farm in the 7-year period 1912 to 1918, inclusive.*

Group and variety.	C. I. No.	Yield per acre (bushels).								
		1912	1913	1914	1915	1916	1917	1918	Average.	
									1912 to 1918	1914 to 1918
Seed flax:										
Select Russian (N. Dak. No. 608)	1	.....	.....	3.7	.....	.....	.....	.....	.....	.....
Damont (N. Dak. No. 1215)	3	.....	.....	11.8	14.5	10.7	15.1	21.7	.....	14.7
Frontier	17	10.1	.....	.....	.....	.....	.....	.....	.....	.....
Russian (N. Dak. No. 155)	19	12.5	5.3	10.0	[a] 14.1	12.7	13.6	19.1	12.4	13.9
Common	.....	11.3	.....	.....	.....	.....	.....	.....	.....	.....
North Dakota Resistant No. 52	8	11.9	4.8	5.8	[a] 13.6	10.7	12.9	20.8	11.5	12.7
Short fiber:										
North Dakota Resistant No. 114	13	.....	.....	11.1	[a] 12.4	6.5	11.4	15.5	.....	11.3
Primost (Minn. No. 25)	12	11.1	5.3	11.6	12.9	9.0	10.0	20.5	11.4	12.8
Smyrna:										
Turkish	7	.....	4.4	1.5	.....	.....	.....	.....	.....	.....
Smyrna	30	.....	.....	.....	6.0	4.1	.....	.....	.....	.....

[a] Damaged by hail.

ALFALFA SEED PRODUCTION.

In 1917 eight quarter-acre plats of established alfalfa were set aside for a seed-production test. On four of these the first crop was left for seed, and on the other four the first crop was cut for hay and the second crop for seed. In 1917 the first crop produced 4.61 bushels per acre and the second crop 3.07 bushels per acre, a difference of 1.54 bushels per acre in favor of the first crop. In 1918 the first crop produced 1.41 bushels per acre and the second crop only 0.13 bushel, a difference of 1.28 bushels per acre in favor of the first crop. Alfalfa seed production is very uncertain, but this test covering two years makes it appear that the best yields are obtained from the first crop.

UTILIZATION OF CROPS WITH LIVE STOCK.

PASTURE GRASSES.

The economical feeding of dairy stock on the reclamation projects involves the use of grass pastures. These irrigated pastures are of a permanent nature, and while the first cost of establishing them is somewhat high the subsequent cost of care is not great. For maximum results the pasture should be located on the best available ground, not only as to fertility but also as to ease of irrigation.

TESTS WITH COWS.

The following pasture mixtures were seeded at the experiment farm in 1915 and pastured in 1916, 1917, and 1918:

Mixture A.—Timothy, 4 pounds; Italian rye-grass, 2 pounds; orchard grass, 6 pounds; brome-grass, 2 pounds; redtop, 4 pounds; Kentucky bluegrass, 4 pounds; perennial rye-grass, 2 pounds; meadow fescue, 2 pounds; tall fescue, 2 pounds; western wheat-grass, 2 pounds; tall oat-grass, 2 pounds. Total, 32 pounds per acre.

Mixture B.—The same as mixture A, except that 2 pounds per acre of white clover and 2 pounds per acre of alsike clover were added.

Mixture C.—The same as mixture B, except that 2 pounds of alfalfa per acre were added.

Mixture D.—Brome-grass, 20 pounds; slender wheat-grass, 12 pounds; alfalfa, 3 pounds. Total, 35 pounds per acre.

Mixtures A, B, and C were sown on quarter-acre plats, while 1 acre was sown to mixture D. These plats were top-dressed lightly with well-rotted manure in the early spring and again in the late fall of 1916. All plats were given frequent irrigation, the aim being to keep the surface soil well supplied with moisture.

Table XIV shows the production of milk and butter fat and the length of time of pasturing for one cow per acre in 1916, 1917, and 1918 on the plats seeded to these mixtures.

TABLE XIV.—*Results of pasturing cows with four pasture mixtures on the Belle Fourche Experiment Farm in 1916, 1917, and 1918.*

Mixture.	Production per acre (pounds).								Time of pasturing per cow per acre (days).			
	Milk.				Butter fat.							
	1916	1917	1918	Average.	1916	1917	1918	Average.	1916	1917	1918	Average.
A	3,124	2,462	1,553	2,379	124.1	110.7	76.8	103.8	136	64	80	93
B	2,512	2,888	2,499	2,633	94.4	129.9	122.4	115.5	112	64	128	101
C	3,656	3,401	3,529	3,528	144.5	153.0	172.9	156.8	160	80	180	140
D	2,598	3,459	4,706	3,587	105.1	137.6	213.2	151.9	180	140	208	176

TABLE XV.—*Rates of seeding per acre of mixtures of grass seed for pasture on the Belle Fourche Experiment Farm in 1916.*

Kind of seed.	Seed per acre (pounds).			
	Mixture 1.	Mixture 2.	Mixture 3.	Mixture 4.
Kentucky bluegrass	3	5		
Brome-grass	4		6	6
Meadow fescue	6	10		
Orchard grass	5			
Tall oat-grass	6		10	6
White clover	2	2	2	
Sweet clover				6
Total	26	17	18	18

Mixture D has given by far the best results in carrying capacity. When the cows were first turned on this mixture in 1916 there was one case of bloat, but no difficulty has been encountered with bloat in using this mixture during the last two years. The number of cow-days that pasture was used is a more reliable measure than the production of the cows as shown in Table XIV, as the differences in milk and butter fat production were probably due less to differences in the pastures than to the different stages of lactation of the cows

in the three seasons. The net returns per acre from pasturing dairy cows on different grass mixtures depend very largely upon the producing capacity of the cows used.

In order to determine whether less elaborate mixtures than those known as A, B, and C would prove satisfactory, a new series of plats was sown in 1916 and includes the mixtures at the rates shown in Table XV.

The pasturing of mixtures planted in 1916 was begun on May 29, 1917. No milk cows were available, so five grade Holstein heifers, from 6 to 12 months old, with an average initial weight of 380 pounds, were used. The results are shown in Table XVI.

TABLE XVI.—*Results of pasturing five heifers on four pasture mixtures on the Belle Fourche Experiment Farm in 1917.*

Mixture.	Area (acres).	Pasture afforded (days).		Gain per acre (pounds).
		Per heifer.	Per acre.	
No. 1	0.50	89	178	340
No. 2	.50	103	206	500
No. 3	.50	88	176	400
No. 4	.25	127	508	500

There was very little difference in the number of days pasturing and the total live weight carried per acre in mixtures 1 to 3, inclusive. While the carrying capacity of mixture No. 4 was very nearly three times as great as the other mixtures, the total gains made per acre with No. 4 were as good as with any other mixture, but the average daily gain was less.

In 1918 one-half acre, sown to mixture No. 1, was pastured with two heifers, having a total weight of 1,185 pounds, for 11 days, May 10 to 21. In this period the heifers made a total gain of 60 pounds. During the remainder of the pasturing season milk cows were used. This half acre afforded pasture for 59 days for one cow, with an average weight of 1,150 pounds, and produced 1,343.5 pounds of milk and 47 pounds of butter fat. On an acre basis, mixture No. 1 pastured for 22 days two heifers having a total weight of 1,185 pounds, and they produced a gain of 120 pounds. One cow, with an average weight of 1,150 pounds, in 118 days produced 2,687 pounds of milk and 94 pounds of butter fat. In carrying capacity this mixture compares favorably with mixture C and is considerably better than mixtures A and B.

One-half acre, sown to mixture No. 2, afforded pasture for two heifers for 74 days; their total initial weight was 1,400 pounds, and the total gain while on pasture was 230 pounds. Figuring on an acre basis, mixture No. 2 produced pasture for two heifers, with an average weight of 1,400 pounds, for 148 days, and they made a gain of 460 pounds per acre.

One-half acre, sown to mixture No. 3, afforded pasture for the same heifers for 59 days, and they made a gain of 110 pounds. On an acre basis, mixture No. 3 produced 118 days of pasture and 220 pounds of gain.

Mixture No. 4 was not pastured in 1918, as no live stock were available. Practically no sweet clover was left in this mixture in 1918, but there was a good stand of brome-grass and tall oat-grass. The mixture was cut for hay early in July and produced at the rate of 1½ tons per acre.

From observations in 1918 it seems the less elaborate grass mixtures for pasturing purposes are as satisfactory and have fully as much carrying capacity as mixtures known as A, B, and C. Sweet clover can not be considered as part of a permanent pasture mixture, but might have a place for the first year or two until the other grasses are well established. Under close pasturing sweet clover will last for two years.

In order to observe the behavior of the different grasses used in these mixtures, separate plats were seeded of the following grasses: White clover, alsike clover, Kentucky bluegrass, redtop, timothy, tall fescue, meadow fescue, orchard grass, slender wheat-grass, tall oat-grass, brome-grass, and alfalfa. When first turned in, the cows seemed to show a preference for timothy, brome-grass, and alfalfa, but later on grazed about the same on all plats. The only grass they refused to eat was the tall fescue. This test was repeated three times during the summer, with about the same results.

A test for frequency of irrigation of pasture grasses was also conducted. Six twentieth-acre plats of the same mixture were used for this purpose. Plats 1 and 4 were irrigated every week, plats 2 and 5 every two weeks, and plats 3 and 6 every three weeks. From the two years' results in the frequency of irrigation test the indications are that irrigating every three weeks gives fully as good results as every week or every two weeks. The need of irrigating grass pastures depends somewhat on the rainfall, and the only safe rule to follow is to see that the grasses are kept in good growing condition. The pastures should be divided so that live stock will be kept off during irrigation and changed from one pasture to the other about every two or three weeks. Pastures handled in this way will have a larger carrying capacity than where the stock are kept on the pasture continuously at all times.

PASTURING ALFALFA WITH HOGS.

The pasturing test in connection with the rotation experiments referred to above is conducted on two quarter-acre plats, one in rotation No. 65 and the other in rotation No. 69. Rotation No. 65 consists of three years of alfalfa, followed by corn, flax, and oats, one

year each. The third-year alfalfa is pastured with hogs, and the crop of corn is hogged. Rotation No. 69 also includes three years of alfalfa with two years of corn and one year of oats. The third-year alfalfa and the two crops of corn are pastured with hogs. The hogs while on alfalfa pasture receive 2 pounds of corn for every 100 pounds of live weight. Each of the third-year alfalfa plats was divided into two parts, to be pastured alternately, the hogs being changed every 10 days or 2 weeks. This arrangement allows for more uniform growth of alfalfa and convenience in irrigating. The pasturing season is divided into two periods. The spring period extends from early May to early July and the summer period from July to the latter part of September. In the first period fall pigs are used, and in the second spring pigs.

FIG. 2.—Hogs on alfalfa pasture in field K, Belle Fourche Experiment Farm, 1918. They were fed a supplementary 2 per cent ration of corn.

On May 18 four fall pigs, averaging 112.5 pounds in weight, were turned in on each rotation plat and pastured until July 8. During this 51-day period the pigs on rotation No. 65 gained 203 pounds, while those on rotation No. 69 gained 234 pounds. On July 11 nine spring pigs, averaging 32.5 pounds in weight, were put on each rotation plat and pastured till September 19. During this 70-day period the pigs in rotation No. 65 gained 282.5 pounds and those in rotation No. 69 gained 300.5 pounds. The total pasturing period was 121 days. Calculating the results on an acre basis, in rotation No. 65 the average live weight per acre was 1,934 pounds, grain fed per acre 4,880 pounds, and total gains per acre 1,942 pounds. It took 2.51 pounds of corn to make 1 pound of gain. In rotation No.

69 the average live weight per acre was 1,979 pounds, grain fed per acre 4,880 pounds, and total gains made per acre 2,138 pounds. It required 2.28 pounds of corn to make 1 pound of gain. (Fig. 2.)

The results of pasturing alfalfa in rotation No. 65 for six years and in rotation No. 69 for four years are shown in Table XVII.

TABLE XVII.—*Results of pasturing alfalfa with hogs on the Belle Fourche Experiment Farm during 4-year and 6-year periods from 1913 to 1918, inclusive.*

Year.	Rotation No.	Time on pasture (days).	Pounds per acre.			Pounds of grain fed per pound of gain.
			Average live weight.	Grain fed.	Gains made.	
1913	65	94	1,808	4,292	1,068	[a] 4.01
1914	65	121	1,815	5,104	1,830	2.79
1915	65	132	2,002	4,787	2,024	2.36
1915	69	132	2,060	4,976	2,108	2.36
1916	65	119	2,286	5,290	1,962	2.70
1916	69	119	2,238	5,128	2,006	2.56
1917	65	119	1,956	4,504	1,742	2.64
1917	69	119	1,956	4,464	1,740	2.56
1918	65	121	1,934	4,880	1,942	2.51
1918	69	121	1,979	4,880	2,138	2.28
Average for rotation:						
No. 65, 6 years	.....	117	1,967	4,809	1,761	2.83
No. 69, 4 years	.....	122	2,058	4,862	1,998	2.44

[a] A ration of equal parts of ground oats, wheat, and barley was fed in 1913.

HOGGING CORN.

On September 26 four spring pigs, with an average initial weight of 95.5 pounds, were turned on the quarter-acre plat of corn in rotation No. 65. A careful estimate made when the hogs were turned into the plat indicated a yield of 56 bushels per acre. They cleaned up the corn in 33 days. During this time they gained 189.5 pounds on the quarter acre, or at the rate of 758 pounds per acre. Six pigs, with an average initial weight of 99 pounds, were turned in on the half-acre plat in rotation No. 69. This plat was estimated as yielding 57 bushels per acre. They cleaned up the corn in 35 days. During this time they gained 333.5 pounds on the half acre, or at the rate of 667 pounds per acre. Rape was sown broadcast in the corn in July in rotation No. 69. A good stand was secured and the rape made good growth, but the hogs refused to eat any of it. The hogs had access to the alfalfa plat on each rotation that had been pastured during the summer. On the basis of 55.8 bushels per acre in rotation No. 65 and 56.7 bushels in rotation No. 69, it took 4.1 pounds of corn to make a pound of gain in rotation No. 65 and 4.7 pounds in rotation No. 69. The hogs made an average daily gain of 1.43 pounds in rotation No. 65, and 1.58 pounds in rotation No. 69. Table XVIII shows the results of hogging corn for seven years in rotation No. 65 and for four years in rotation No. 69.

TABLE XVIII.—*Results of harvesting corn with hogs on the Belle Fourche Experiment Farm during 4-year and 7-year periods from 1912 to 1918, inclusive.*

Year.	Rotation No.	Length of test.	Per acre basis.			Corn fed per pound of gain.	Average.	
			Live weight when turned on.	Gains.	Estimated corn yield.		Initial weight.	Daily gain per acre.
		Days.	*Pounds.*	*Pounds.*	*Bushels.*	*Pounds.*	*Pounds.*	*Pounds.*
1912	65	26	680	340	28.7	4.7	85	1.63
1913	65	11	1,632	560	34.0	3.4	51	1.59
1914	65	20	1,708	582	34.8	3.3	106	1.81
1915	65	15	1,620	548	40.6	4.2	81	1.85
	69	10	1,780	451	34.0	4.2	89	1.87
1916	65	24	1,252	518	59.1	5.9	104	1.80
	69	26	1,268	456	47.7	5.8	105	1.53
1917	65	30	1,280	682	67.4	5.5	108	1.60
	69	37	1,206	537	55.4	5.7	109	1.38
1918	65	33	1,530	738	55.8	4.1	95	1.42
	69	35	1,190	667	56.7	4.7	99	1.58
Average for rotation:								
No. 65, 7 years		22	1,386	569	45.7	4.4	90	1.67
No. 69, 4 years		27	1,361	527	48.4	5.1	100	1.59

HARVESTING ALFALFA, CORN, AND BEET TOPS WITH SHEEP.

Rotation 71 is a 6-year rotation—three years of alfalfa and one year each of corn, beets, and oats. The third-year alfalfa is pastured with sheep and their lambs. The corn is harvested with lambs only. While the lambs are pasturing the corn they have access to the third-year alfalfa pasture and the beet tops. The quarter-acre of third-year alfalfa furnished pasture for two ewes and three lambs for 81 days and for four lambs for 28 days. The average weight of the ewes was 140 pounds and of the lambs 33 pounds, when first turned on pasture on May 13. The ewes maintained their weight during the pasturing period. The lambs gained 0.46 pound a day during the 81-day pasturing period while sucking the ewes and 0.3 pound a day while in pasture alone. The total gain of the lambs while on alfalfa pasture was 134.5 pounds for the quarter-acre plat, or at the rate of 538 pounds per acre. The average live weight pastured per acre of alfalfa was 1,800 pounds. On September 6 the four lambs that had been pastured on the alfalfa during the summer and four lambs from the range were turned into the corn plat, which was estimated as yielding 57 bushels per acre. The total initial weight of the eight lambs was 577 pounds and the average weight 72 pounds. After October 18 the lambs had access to the beet tops. The total pasturing period was 61 days. During this time they made 153 pounds of gain from the quarter-acre of corn, one-quarter acre of beet tops, and what was left of the quarter acre of alfalfa pasture, or at the rate of 612 pounds per acre. Rape was seeded in the corn in July. A good stand and good growth were obtained, but while the lambs had access to the rape they scoured badly and during the

first period of 28 days gained only 46 pounds, while for the last period of 33 days they made a gain of 107 pounds. From this year's observation the sowing of rape does not seem to be a desirable practice. The lambs that were pastured on alfalfa during the summer made decidedly better gains while pastured on the corn than those from the range. The alfalfa-pastured lambs made 66 per cent of the total gain, while the range lambs made only 34 per cent. From observations made in 1916, 1917, and 1918, it appears that lambs will make as good gains as hogs when used for harvesting corn in the field and will clean up the field more thoroughly than hogs. There is some danger from bloat when pasturing sheep on alfalfa, but the loss from this cause has not been serious on the Belle Fourche project. Farmers pasturing sheep in large numbers on alfalfa report that their losses from bloat are very small, and less than they have on the range from other causes. Harvesting alfalfa and corn with hogs or sheep seems to be a most desirable practice. On the heavy gumbo soils alfalfa alone so far has not shown any beneficial effect on the crops that follow. In rotation 65 and 69, where alfalfa has been pastured with hogs, the yields of corn following alfalfa have been materially increased. This is also true of oats following the pasturing of corn. In rotation 71, where sheep are used for pasturing the alfalfa, corn, and beet tops, similar benefits are apparent. In rotation 71 the highest yield of oats was obtained. The yield of beets following the pasturing of corn was also very satisfactory, being within one-half ton of the maximum yield of all beet plats in the rotation. The saving of labor and the improvement in the soil are important points in favor of harvesting certain farm crops by pasturing with sheep or hogs.

PASTURING SHEEP ON ALFALFA.

The pasturing of sheep on alfalfa was continued in 1918. This completes the fourth year that this test has been conducted, in addition to those carried on in rotation experiments. At no time during the pasturing period in this test was there any trouble with bloat or any other ill effects from pasturing alfalfa. The size of this pasture was 1½ acres, and it was first pastured in 1917 with the following results. On May 24 nine ewes, 2 to 6 years old, and four ewes each with twin lambs were placed on the pasture. These sheep had good pasture up to August 29, but at this time the alfalfa on all three plats was grazed down rather short, so the sheep were taken off until September 7, after which they were again pastured until October 5. The old ewes made a gain for the season of 258 pounds, and the lambs gained 244 pounds. The lambs while on alfalfa pasture made an average daily gain of 0.32 pound per day. Figuring the carrying capacity on an acre basis, the results for 1917

would be eight ewes, averaging 130 pounds, and four lambs, averaging 57 pounds, for a pasturing period of 130 days.

In 1918, on this same pasture, 16 dry ewes, 1 to 7 years old, were started on pasture on May 13. Their total live weight was 1,900 pounds. They were pastured for a period of 124 days, during which time they made a gain of 240 pounds. The carrying capacity for 1918 was 1,266 pounds and the gain 160 pounds per acre. While pasturing alfalfa with sheep has a very beneficial effect on the crops which follow, it is injurious to the alfalfa stand, so that such pasturing should be done only on alfalfa that is to be plowed up before the beginning of the following crop season.

SILAGE TEST.

A test of silage crops has been conducted for two years, the yields of which are shown in Table XIX. (Fig. 3.)

FIG. 3.—Silage test in field P, Belle Fourche Experiment Farm, August 15, 1918. Crops from left to right: Marten White Dent corn, Red Cob corn, Amber sorghum, and Mammoth Black Russian sunflower.

The land both years was manured at the rate of 12 loads per acre and fall plowed. The first three varieties of corn produced by far the best silage. The corn was well dented at the time it was cut. The Red Cob, a southern variety, produced the largest yield per acre, but was very immature at the time of harvest. It produced ensilage that was sloppy and too sour and consequently low in feeding value. The Red Amber sorghum produced silage that was also very sour, and the stock refused to eat it. The Mammoth Russian sunflower produced good silage, which seemed to be relished

by stock as much as the good corn silage. On the Belle Fourche project ensilage corn should be planted as early as corn used for the grain. This will allow the crop to mature and be ready for the silo before the first fall frost. Ensilage crops should be judged by their feeding value rather than by bulk or weight alone. For this reason, corn varieties that have been known to mature in the locality should be used rather than the so-called ensilage corn grown farther south.

TABLE XIX.—*Yields of corn used for silage on the Belle Fourche Experiment Farm in 1917 and 1918.*

Crop.	Yield per acre (tons.)		
	1917	1918	2-year average.
Sweet fodder corn	8.67	8.57	8.62
Payne White Dent corn	10.37	8.17	9.27
Marten White Dent corn	9.55	7.63	8.59
Red Cob corn	11.98	14.33	13.15
Red Amber sorghum	.....	11.27	11.27
Mammoth Russian sunflower	12.59	12.84	12.71

EXPERIMENTS WITH HOGS.[1]

In cooperation with the Division of Animal Husbandry of the Bureau of Animal Industry, some experiments with hogs were started in 1917. These experiments included tests of different grain rations as a supplement to alfalfa pasture for hogs; a comparison of the relative value of corn, barley, and shorts as a supplement to alfalfa pasture for pigs and for sows and litters; the hogging of corn; and dry-lot feeding. The results of pasturing alfalfa with various grain rations for 1918 are here summarized. The alfalfa pasturing experiments were conducted on well-established alfalfa, 3 or more years old, on duplicate quarter-acre plats, and each of these plats was divided into two equal parts. The hogs were changed from one to the other every 10 days or 2 weeks. Frequent irrigations were given to keep the alfalfa in good growing condition. Twelve lots of hogs were used. Two lots received no grain, two lots were fed a 2 per cent ration of barley, two lots a 2 per cent ration of shorts, two lots a 2 per cent ration of corn, two lots were given corn in a self-feeder, and two lots corn and tankage in a self-feeder. The pasturing was begun on May 18 and continued until July 8, a period of 51 days. The hogs used were good grades of the Duroc-Jersey breed, averaging about 112 pounds in weight at the beginning of the experiment.

Table XX summarizes the results obtained during this period.

[1] This work was under the immediate supervision of S. H. Bober, who assisted in the preparation of this part of the report.

TABLE XX.—*Results of pasturing fall pigs on alfalfa, supplemented by various grain rations, on the Belle Fourche Experiment Farm for a period of 51 days from May 18 to July 8, 1918.*

Items of comparison.	No grain ration.	Supplemental grain ration.				
		2 per cent addition of—			In self-feeder.	
		Barley.	Shorts.	Corn.	Corn.	Corn and tankage.
Number of pigs per acre	12	16	16	16	16	16
Average initial weight ....pounds..	100.0	112.5	112.5	112.5	112.5	112.5
Average final weight ....do....	108.5	167.0	167.0	167.0	196.0	190.5
Average carrying capacity per acre ....do....	1,254	2,238	2,242	2,239	2,470	2,423
Total gain per acre ....do....	104	879	883	874	1,342	1,253
Gain per acre per day ....do....	2.0	17.2	17.3	17.1	26.4	24.5
Average gain per pig per day ....do....	.17	1.07	1.08	1.07	1.64	1.53
Grain fed per pound of gain ....do....	None.	2.64	2.62	2.65	3.37	3.45
Tankage fed per pound of gain ....do....	.....	.....	.....	.....	.....	.21

On July 11, 1918, the lots that were fed a grain ration were replaced by spring pigs weighing about 32 pounds each. No tankage could be had at this time, so the lots given corn and tankage in a self-feeder were discontinued. The lots receiving no grain were continued for the remainder of the season. This pasturing period was continued for 70 days, closing on September 19.

Table XXI summarizes the results obtained for this period with the spring pigs receiving supplemental rations and with the fall pigs receiving no grain.

TABLE XXI.—*Results of pasturing pigs on alfalfa, supplemented by various grain rations, on the Belle Fourche Experiment Farm for a period of 70 days* [1] *from July 11 to September 19, 1918.*

Items of comparison.	No grain ration.	Supplemental grain ration.			
		2 per cent addition of—			Corn in self-feeder.
		Barley.	Shorts.	Corn.	
Number of pigs per acre	12	36	36	36	56
Average initial weight ....pounds..	109.0	32.5	32.5	32.5	32.5
Average final weight ....do....	110.5	63.0	64.5	64.5	90.5
Average carrying capacity per acre ....do....	1,316	1,722	1,748	1,753	3,453
Total gain per acre ....do....	21	1,105	1,166	1,166	3,267
Gain per acre per day ....do....	.3	15.7	16.5	16.6	51.8
Average gain per pig per day ....do....	.02	.44	.45	.45	.92
Grain fed per pound of gain ....do....	None.	2.31	2.21	2.19	2.94

[1] The length of period for the self-feeder lot was 63 days.

Table XXII presents a summary of the results obtained during the entire pasturing season in 1918.

TABLE XXII.—*Results of pasturing fall and spring pigs on alfalfa, supplemented by various grain rations, on the Belle Fourche Experiment Farm, between May 18 and September 19, 1918.*

Items of comparison.	No grain ration.	Supplemental grain ration.			
		2 per cent addition of—			Corn in self-feeder.
		Barley.	Shorts.	Corn.	
Time on pasture.....days..	121	121	121	121	114
Average carrying capacity per acre.....pounds..	1,264	1,940	1,956	1,957	3,013
Total gain per acre.....do....	125	1,984	2,042	2,040	4,609
Total grain fed per acre.....do....	None.	4,880	4,880	4,880	14,132
Pounds of grain per pound of gain.....do....	...do....	2.41	2.39	2.39	3.07

Table XXIII summarizes the results obtained during the entire pasturing seasons of 1917 and 1918.

TABLE XXIII.—*Results of pasturing pigs on alfalfa, supplemented by various grain rations, on the Belle Fourche Experiment Farm in 1917 and 1918.*

Year.	Supplemental ration.	Time on pasture (days).	Pounds per acre.			Pounds of grain fed per pound of gain.
			Average live weight.	Grain fed.	Gains made.	
1917.....	No grain.....	115	1,305	None.	117	None.
1918.....	.....do.....	121	1,264	None.	125	None.
1917.....	Barley[1].....	119	1,961	4,552	1,785	2.55
1918.....	.....do.....	121	1,940	4,880	1,984	2.41
1917.....	Shorts[1].....	119	1,987	4,552	1,903	2.39
1918.....	.....do.....	121	1,956	4,880	2,042	2.39
1917.....	Corn[1].....	119	1,945	4,504	1,741	2.58
1918.....	.....do.....	121	1,957	4,880	2,040	2 39
1918.....	Corn in self-feeder.....	114	3,013	14,132	4,609	3.07
Average for 2 years.....	No grain.....	118	1,284	None.	121	None.
Do.....	Barley[1].....	120	1,950	4,716	1,884	2.48
Do.....	Shorts[1].....	120	1,971	4,716	1,972	2.39
Do.....	Corn[1].....	120	1,951	4,692	1,890	2.48
One year.....	Corn in self-feeder.....	114	3,013	14,132	4,609	3.07

[1] Supplemental 2 per cent grain ration.

The results obtained in 1918 with various supplemental feeds for hogs on alfalfa pasture are practically the same as in 1917. It appears that a pound of shorts or ground barley is as good as a pound of corn as supplemental feed for hogs on alfalfa pasture. Which of these feeds to use will depend largely on the market prices. The outstanding features of the results in 1917 and 1918 are the increased gains per acre obtained where a grain ration was given as compared with the gains made on alfalfa pasture alone. The hogs that received no grain were in a very poor and unthrifty condition at the close of the pasture season and would scarcely be considered good feeders. Another outstanding feature is the satisfactory results obtained where corn in a self-feeder on alfalfa pasture was used in 1918. Table XXIV shows the net returns per acre of alfalfa pasture, exclusive of labor or investment, figuring grain at 1 cent and pork at 7

cents per pound, and also figuring grain at 3 cents and pork at 15 cents, this last cost being representative for 1917 and 1918.

TABLE XXIV.—*Net returns per acre in pasturing pigs on alfalfa, with supplemental rations of grain at different prices per pound, on the Belle Fourche Experiment Farm in 1917 and 1918.*

Year.	Supplemental ration.	Grain at 1 cent and pork at 7 cents.	Grain at 3 cents and pork at 15 cents.
1917	No grain	$8.19	$17.55
1918	do	8.75	18.75
1917	Barley [1]	79.43	131.19
1918	do	90.08	151.20
1917	Shorts [1]	87.69	148.89
1918	do	94.14	159.45
1917	Corn [1]	76.83	126.03
1918	do	94.00	159.60
1918	Corn in self-feeder	181.31	267.39
Average for 2 years	No grain	8.47	18.15
Do	Barley [1]	84.75	141.19
Do	Shorts [1]	90.91	154.17
Do	Corn [1]	85.41	142.81
One year	Corn in self-feeder	181.31	267.39

[1] Supplemental 2 per cent grain ration.

HOGGING CORN.

A 2-acre field of corn was divided into four half-acre plats and hogged as follows: Lot 1, corn alone; lot 2, corn with alfalfa hay in rack; lot 3, corn and third-cutting alfalfa pasture; lot 4, corn with 60 per cent tankage in self-feeder. On September 26 five hogs averaging about 100 pounds each were turned into each lot. The results of the experiment are summarized in Table XXV.

TABLE XXV.—*Results of harvesting corn with hogs on the Belle Fourche Experiment Farm in 1918.*

Supplemental feed.	Length of test.	Per acre basis.			Feed consumed per pound of gain.		Average.	
		Live weight when turned on.	Gains.	Estimated corn yield.	Corn.	Supplement.	Initial weight.	Daily gain per hog.
	Days.	*Pounds.*	*Pounds.*	*Bushels.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
None	32	999	374	38.3	5.73	None.	100	1.16
Alfalfa hay	35	1,000	431	39.6	5.15	0.45	100	1.23
Alfalfa pasture	35	999	481	36.9	4.30	Pasture.	100	1.37
Tankage in self-feeder	28	998	592	38.4	3.63	0.25	100	2.11

In hogging corn, more economical gains were produced when the corn was supplemented by tankage in a self-feeder, alfalfa pasture, or good third-cutting alfalfa hay. Lot 1, having corn alone, required 5.73 pounds of corn to make 1 pound of gain, lot 2 required 5.15 pounds of corn, lot 3, 4.3 pounds of corn, and lot 4, 3.63 pounds of corn and tankage to make a pound of gain. Careful estimates

were made of the yield of corn on each plat. Figuring the gains made by the hogs at 15 cents per pound, lot 1 paid $1.41 per bushel of corn; lot 2, $1.59; lot 3, $1.87; and lot 4, $2.10. After the four lots were removed, the plats maintained 15 head of spring gilts for two weeks on what corn was left. When hogs are fattened in a cornfield they should be removed before the corn gets too low and replaced by stockers or breeding sows. This practice insures the minimum of waste. The harvesting of corn with hogs requires less labor in growing and marketing the crop and produces more economical gains, especially when supplemented with alfalfa pasture or tankage. The beneficial effects to the land and the increased yields in crops that follow are all points in favor of the practice.

DRY-LOT FEEDING.

To get some information as to the feeding value of sugar beets for fattening hogs when used alone and with supplements, three lots of hogs were fed as follows: Lot 1, sugar beets alone; lot 2, sugar beets and 4 per cent of corn; lot 3, sugar beets and 4 per cent of corn and tankage.[1] Each lot consisted of six pigs with an average initial weight of about 79 pounds. The feeding continued for 42 days. The results are summarized in Table XXVI.

TABLE XXVI.—*Results of fattening pigs on sugar beets alone and with supplemental feeds on the Belle Fourche Experiment Farm in 1918.*

Items of comparison.	Sugar beets alone.	Sugar beets plus 4 per cent—	
		New corn.	New corn and 1:15 tankage.
Number of pigs	6	6	6
Length of period ... days	42	42	42
Average initial weight ... pounds	79.5	79.5	79.5
Average final weight ... do	94.5	126.0	138.5
Average gain per pig ... do	15.0	46.5	59.0
Average daily gain per pig ... do	.35	1.4	1.4
Feed required per 100 pounds of gain:			
Sugar beets ... do	4,446	767	553
Corn ... do	None.	383	300
Tankage ... do	None.	None.	19.9

From the results obtained, it will be seen that sugar beets alone do not make a desirable feed for hogs. The gains made were very small and the hogs were in a very unthrifty condition at the end of the test. It required 4,446 pounds of sugar beets to make 100 pounds of gain. Sugar beets fed in combination with corn and corn and tankage together produced satisfactory gains, the latter being the most economical.

[1] Where tankage was fed with corn in this and the following cases it was used in the proportion of 1 part of tankage to 15 parts of corn.

CARRYING SOWS AND LITTERS ON ALFALFA.

Eight Duroc-Jersey sows with litters were used in a test comparing shorts, ground barley, shelled corn, and shelled corn and tankage as supplemental feeds to alfalfa pasture. There were four quarter-acre lots and two sows and their litters to each lot, the sows and pigs in each lot receiving a 2½ per cent grain ration. The pigs were fed approximately 2½ per cent grain in a creep by themselves. The test was begun on May 16 and ended on June 27. The results show that to make 100 pounds of gain on pigs (less loss in weight of sows) it took 354 pounds of shorts in lot 1, 355 pounds of ground barley in lot 2, 294 pounds of shelled corn in lot 3, and 244 pounds of shelled corn and 12.3 pounds of tankage in lot 4.

The figures in Table XXVII show the benefit of tankage in the ration, the sows and litters in lot 4 making their gains on less grain than the other lots.

TABLE XXVII.—*Results of feeding sows and their litters varying grain rations to supplement alfalfa pasture on the Belle Fourche Experiment Farm for a period of 42 days from May 16 to June 27, 1918.*

Items of comparison	Supplemental 2½ per cent ration.			
	Shorts.	Barley.	Corn.	Corn and tankage.
Number of sows per acre	8	8	8	8
Number of pigs per acre	64	64	64	60
Average initial weight of sows ... pounds	295	267	226	230
Average initial weight of pigs ... do	14	9.5	9	14.5
Average final weight of sows ... do	278	254	191	220
Average final weight of pigs ... do	34.5	26	30	40.5
Average daily gain of pigs ... do	.48	.40	.50	.61
Gain per acre (gain of pigs less loss of sows) ... do	1,174	970	1,070	1,478
Grain fed per pound of gain:				
Sows and pigs ... do	3.54	3.55	2.94	[a] 2.44 [b] .12
Pigs ... do	3.16	3.20	2.33	[a] 2.32 [b] 0.11

[a] Corn. [b] Tankage.

TABLE XXVIII.—*Results of pasturing alfalfa with sows and their litters on the Belle Fourche Experiment Farm for a period of 43 days in 1917 and for 42 days in 1918.*

Year.	Supplemental ration.	Per acre basis.			Daily loss per sow.	Average daily gain.		Pounds of grain fed per pound of gain.	
		Number.		Live weight.		Per pig.	Per litter.	Sows and pigs.	Pigs.
		Sows.	Pigs.						
1917	2½ per cent barley	8	64	2,351	0.56	0.36	2.9	3.22	2.60
1918	2½ per cent barley	8	64	3,233	.30	.40	3.2	3.55	3.20
1917[a]	2½ per cent corn	8	56	2,039	.94	.32	2.2	4.79	2.59
1918	2½ per cent corn	8	64	2,931	.83	.50	4.0	2.94	2.33
1917	2½ per cent corn and 1.15 tankage	8	72	2,697	.76	.44	4.0	[b] 2.62 [c] .14	[b] 2.13 [c] .11
1918	2½ per cent corn and 1.15 tankage	8	60	3,465	.23	.61	4.6	[b] 2.44 [b] .12	[b] 2.32 [c] .11
1918	2½ per cent shorts	8	64	3,869	.41	.48	3.9	3.54	3.16
Average for 2 years	2.4 per cent barley	8	64	2,792	.43	.38	3.1	3.38	2.90
Do	2.4 per cent corn	8	60	2,485	.88	.41	3.1	3.86	2.46
Do	2.4 per cent corn and 1.15 tankage	8	66	3,081	.49	.53	4.3	[b] 2.53 [c] .12	[b] 2.22 [c] .11
One year	2.5 per cent shorts	8	64	3,869	.41	.48	3.9	3.54	3.16

[a] The test of this lot was for 39 days only. [b] Corn. [c] Tankage.

A summary of the results obtained in feeding sows and their litters various grain rations supplemental to alfalfa pasture for 1917 and 1918 is presented in Table XXVIII. The lot receiving corn and tankage made the best and also the most economical gains.

PASTURING BREEDING SOWS ON ALFALFA WITH VARIOUS SUPPLEMENTAL GRAIN RATIONS.

Eight Duroc-Jersey sows were used in this test. There were four quarter-acre alfalfa pastures, and two sows were put on each lot. Three lots received grain supplements of 1 per cent, or 1 pound of grain daily per 100 pounds live weight. One lot was pastured on alfalfa without any grain ration. The test began on July 8, about 10 days after the sows weaned their pigs, and ended on September 16, a period of 70 days.

From Table XXIX it will be seen that the sows receiving 1 per cent of shelled corn and tankage made the best average daily gain during the period. The sows receiving no grain ration lost slightly in weight.

TABLE XXIX.—*Results of carrying breeding sows through the summer on alfalfa pasture supplemented by various grain rations on the Belle Fourche Experiment Farm, July 8 to September 16, 1918.*

Items of comparison.	No grain ration.	Supplemental 1 per cent ration.		
		Barley.	Corn.	Corn and 1:15 tankage.
Number of sows per acre	8	8	8	8
Average initial weight ... pounds	236	265.5	207	216
Average final weight ... do	229	306.5	242	290
Average gain per sow ... do	− 7	41	35	74
Average daily gain per sow ... do	− .09	.58	.49	1.06
Pounds of grain fed daily per sow	None.	2.89	2.28	[a] 2.52 [b] .16

[a] Corn. [a] Tankage.

TABLE XXX.—*Results of carrying breeding sows through the summer on alfalfa pasture on the Belle Fourche Experiment Farm in 1917 and 1918.*

Year	Supplemental ration.	Time on pasture.	Average.	
			Live weight per acre.	Daily gain per sow.
		Days.	*Pounds.*	*Pounds.*
1917	No grain	67	1,347	0.15
1918	do	70	1,859	− .09
1917	1 per cent corn	67	1,406	.34
1918	do	70	1,795	.49
1917	1 per cent corn and 1:15 tankage	67	1,519	.73
1918	do	70	2,025	1.06
1918	1 per cent barley	70	2,292	.58
Average for two years	No grain	68	1,603	.03
Do	1 per cent corn	68	1,600	.41
Do	1 per cent corn and 1:15 tankage	68	1,772	.89
One year	1 per cent barley	70	2,292	.58

A summary of results obtained in carrying breeding sows through the summer on alfalfa for 1917 and 1918 is presented in Table XXX.

The average for the two years shows that sows can be maintained on alfalfa without grain; but this practice is not recommended, because it is a detriment to the litters the sows are carrying. The lot receiving 1 per cent of corn and tankage made better daily gains per sow than the lots receiving 1 per cent of barley, 1 per cent of corn, and 1 per cent of shorts. They were also the thriftiest looking sows at the end of the test.

TREE PLANTING.

Tests of various kinds of trees for shade, windbreak, and ornamental planting have been carried on in cooperation with the Forest Service since 1909. Previous to 1912 all the work was done on dry land. In 1912 plantings were begun on irrigated land.

DRY LAND.

Table XXXI shows the species that have survived, the date planted, and the growth of each species for the season.

TABLE XXXI.—*Results of experimental tree plantings on the Belle Fourche Experiment Farm in 1918.*

Species.	Date planted.	Height in the fall of 1917.		Growth in 1918.	Total height.	
		Ft.	*In.*	*Inches.*	*Ft.*	*In.*
Dry-land plantings:						
Siberian pea tree	1909	5	8	8	6	4
Russian white olive	1909	9	0	10	9	10
White elm	1909	8	10	14	10	0
Hackberry	1910	8	3	12	9	3
Honey locust	1909	8	2	24	10	2
Red cedar	1909	5	0	12	6	0
Black Hills spruce	1909	2	4	5	2	9
Plantings on irrigated land:						
Golden willow	1914	11	0	30	13	6
White willow	1912	15	0	24	17	0
Siberian pea tree	1913	6	6	8	7	2
White elm	1912	9	6	30	11	10
Green ash	1912	8	7	18	10	1
Cottonwood	1914	10	3	24	12	3
Honey locust	1914	8	7	36	11	7
Box elder	1914	6	10	30	9	2
Bull pine	1914	2	2	10	3	0
Jack pine	1914	3	1	.....	4	1
Black Hills spruce	1916	7	0	4	..	11
White cedar	1916	1	0	6	1	0
Russian white olive	1913	12	0	24	14	0

The following species were planted in 1909 on dry land: Cottonwood, golden willow, white willow, black locust, Siberian pea tree, Russian white olive, white elm, honey locust, green ash, red cedar, and Black Hills spruce. In 1910 hackberry and Scotch pine were planted. The species that have survived to date are listed in Table XXXI. The green ash seemed to be one of the most promising trees for dry-land conditions, but last year they were badly infested with borers and practically all died during the summer of 1918.

IRRIGATED LAND.

About 7 acres are used for testing trees under irrigation for windbreak purposes. Plantings were begun in 1912. Table XXXI shows the species of trees, their date of planting, their total height, and their growth during the season of 1918. (Fig. 4.)

In 1918 some 2,000 bull pines were interplanted with the cottonwoods and a stand of about 50 per cent was secured. It takes evergreens three or four years to get well established, and as the ground is needed the cottonwoods will be cut out. Evergreens are excellent for windbreak purposes and once they are well established make rapid growth. Much better success has been had with evergreens when planted with other trees that afford them protection than when planted alone.

FIG. 4.—Irrigated trees on the Belle Fourche Experiment Farm, August 15, 1918. From left to right: Russian white olive, white elm, and cottonwood. Planted in 1913.

ORCHARD.

In 1916 the following varieties of apples were planted: Wealthy, Hibernal, Longfield, Patten (*Patten's Greening*), Whitney, Yellow Transparent, Jewell (*Jewell's Winter*), Oldenburg (*Duchess of Oldenburg*), and Ben Davis. In the same year the following varieties of crab apples were planted: Virginia, Transcendent, Minnesota, and Florence. In 1917 plantings were made of the Wolf, Wyant, and De Soto varieties of plums and of the Opata and Compass cherry varieties of sand cherry–plum hybrids. In 1918 the Wyant and Surprise varieties of plums and the Sapa and Hanska varieties of sand cherry–plum hybrids were planted. A good stand of all varieties was secured. The only case of winterkilling was one variety—Ben Davis. This is not hardy enough for the locality. Apples and plums for

home use can be grown successfully provided they are given proper care as to planting, cultivation, pruning, and spraying. The ground should be thoroughly subdued and fall plowed before planting. A desirable distance to plant for this locality is 20 by 24 feet. Two-year-old stock is preferable to older trees, as this size is much easier to plant and establish than older and larger trees. Trees should be headed low and a little pruning done each year in order to give the trees the desired shape. The orchard should be given clean cultivation at all times and kept well irrigated during the early summer. Whenever possible a late-fall irrigation is desirable, as the trees will go through the winter in better condition when provided with a good supply of moisture.

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